

REMARKS

By this amendment, claims 1-19 have been cancelled, and claims 20-34 have been added. Thus, claims 20-34 are now active in the application. Reexamination and reconsideration of the application are respectfully requested. All of the new claims 20-34 are directed to the elected invention.

The specification and abstract have been carefully reviewed and revised to make grammatical and idiomatic improvements in order to aid the Examiner in further consideration of the application. The amendments to the specification and abstract are incorporated in the attached substitute specification and abstract. No new matter has been added.

Attached hereto is a marked-up version of the changes made to the specification and Abstract by the current amendment. The attachment is captioned "Version with markings to show changes made."

In item 3 on pages 2 and 3 of the Office Action, the drawings were objected to for failing to show the "tangential rib" of claim 14. Claim 14 has now been cancelled, and the feature of the "tangential rib" has not been recited in any of the new claims 20-34. Therefore, it is submitted that the drawing objection has been obviated.

In items 4-12 on pages 3-14 of the Office Action, claims 1, 2, 8 and 15-17 were rejected under 35 U.S.C. 102(b) as being anticipated by House (U.S. 5,883,967); and claims 3-7 and 9-14 were rejected under 35 U.S.C. 103(a) as being unpatentable over various combinations of House with Stiles (U.S. 2004/0228500), D'Hoogh (U.S. 2003/0031337), Hirosawa et al. (U.S. 5,521,886), and Frasl (U.S. 2003/0112995). These rejections are believed moot in view of the cancellation of claims 1-17. Furthermore, these rejections are believed clearly inapplicable to the new claims 20-34, for the following reasons.

With exemplary reference to the present drawing figures, and with particular reference to Fig. 2, new independent claim 20 sets forth a speaker comprising: a magnet circuit assembly 24 including a frame, and a permanent magnet 21; a diaphragm assembly 100 including a diaphragm 27, and a voice coil 28 attached to an outer peripheral portion of the diaphragm 27; and an edge 29 supporting the diaphragm 27 with respect to the frame 26, an outer periphery of the edge 29 being connected to the frame 26, and an inner periphery of the edge 29 being connected to a joint part of the diaphragm 27, the joint part being disposed inwardly of the outer peripheral portion of

the diaphragm 27; wherein the diaphragm 27 has a through hole 27a formed therethrough in a thickness direction thereof, the through hole 27a being located outwardly of the joint part of the diaphragm 27 and inwardly of the outer peripheral portion of the diaphragm such that the outer peripheral portion of the diaphragm 27 is interposed between the through hole 27a and the voice coil 28.

Thus, in contrast to the present invention of claim 27, the House patent discloses a speaker in which a diaphragm is secured to a voice coil 18 only by ribs 43. There is no disclosure or suggestion in the House patent of the provision of a through hole formed through the diaphragm 12 such that the through hole is located outwardly of a joint part (where the edge 30 is joined to the diaphragm 12) of the diaphragm 12 and inwardly of the outer peripheral portion of the diaphragm 12 such that the outer peripheral portion of the diaphragm 12 is interposed between the through hole and the voice coil 18, as required by claim 20.

On page 4 of the Office Action under the subheading “Regarding claim 2 ...”, the Examiner indicated that the House patent teaches a “through-hole” provided in the diaphragm 12, the through hole being “provided between ribs Fig. 2 #43”. However, claim 20 requires that the through-hole be located inwardly of the outer peripheral portion of the diaphragm such that the outer peripheral portion of the diaphragm is interposed between the through-hole and the voice coil. This is not the case in the House patent since no peripheral portion of the diaphragm is interposed between the voice coil 18 and the “through-hole” defined between the ribs 43.

In other words, in the House patent, the opening (“through-hole”) defined between the ribs 43 opens radially outwardly such that there is no outer peripheral portion of the diaphragm disposed outwardly of the opening.

Thus, in view of the above-discussed clear distinctions between the present invention of claim 20 and the House patent, it is believed apparent that the present invention of claim 20 is not anticipated by the House patent. Furthermore, there is no teaching or suggestion in the House patent or in any of the other references of record that would have caused a person having ordinary skill in the part to modify the House patent in such a manner as to result in or otherwise render obvious the present invention of claim 20. In this regard, it is noted that the Examiner cited the Stiles publication for teaching a guide that is provided on the diaphragm and that is a recess, the D’Hoogh publication was cited by the Examiner for teaching a guide that is provided

on a diaphragm and that is a horizontal recess, the Hirosawa et al. patent was cited by the Examiner for teaching a guide that is provided on a diaphragm and that is a U-shaped groove, and the Frasl publication was cited by the Examiner for teaching an edge with a tangential rib. However, these disclosures of the secondary references provide no teaching or suggestion that would have obviated the above-discussed shortcomings of the House patent.

Therefore, for the reasons presented above, it is believed clear that a person having ordinary skill in the art would not have found it obvious to modify the House patent or to make any combination of the references of record in such a manner as to result in or otherwise render obvious the present invention of claim 20. Therefore, it is respectfully submitted that claim 20, as well as claims 21-34 which depend therefrom, are clearly allowable over the prior art of record.

In view of the foregoing amendments and remarks, it is respectfully submitted that the present application is clearly in condition for allowance. An early notice thereof is earnestly solicited.

If, after reviewing this Amendment, the Examiner feels there are any issues remaining which must be resolved before the application can be passed to issue, it is respectfully requested that the Examiner contact the undersigned by telephone in order to resolve such issues.

Respectfully submitted,

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DESCRIPTION

SPEAKER, MODULE USING THE SAME, ELECTRONIC EQUIPMENT AND DEVICE, AND SPEAKER PRODUCING METHOD

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This application is a U.S. national phase application of PCT International Application PCT/JP2005/004763, filed March 17, 2005.

TECHNICAL FIELD

10 The present invention relates to a speaker, a device using the speaker, and a method of manufacturing the speaker.

BACKGROUND ART

Fig. 16 is a sectional view of a conventional speaker disclosed in 15 Unexamined Japanese Utility Model Publication No. 57-111196. Permanent magnet 1 is sandwiched between upper plate 2 and yoke 3 to form magnetic circuit assembly 4. Frame 6 is fitted to yoke 3. The outer periphery of edge 9 is attached onto frame 6. Voice coil 8 attached to diaphragm 7 is placed in magnetic gap 5 in magnetic 20 circuit assembly 4. Diaphragm 7 and edge 9 along the outer periphery of diaphragm 7 are unitarily formed of one resin film sheet.

The problem of the above speaker is that its performance thereof is deteriorated when the speaker is downsized to meet market requests, because the size of diaphragm 7, edge 9, or permanent 25 magnet 1 must be reduced.

SUMMARY OF THE INVENTION

A speaker of the present invention includes: a magnet circuit

assembly including a frame and a permanent magnet; a diaphragm assembly including a diaphragm, and a voice coil attached to the outer periphery of the diaphragm; and an edge that is attached to the frame along the outer periphery thereof and joined onto the diaphragm in a 5 position more peripherally inward than the voice coil along the inner periphery thereof to partly overlap the diaphragm, and that supports the diaphragm assembly with respect to the frame. The edge partly overlaps the diaphragm. This structure allows the speaker to be downsized, without reducing the sizes of the permanent magnet and 10 edge.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of a speaker in accordance with a first exemplary embodiment of the present invention.

15 Fig. 2 is a sectional view of a speaker in accordance with a second exemplary embodiment of the present invention.

Fig. 3 is a sectional view of a speaker in accordance with a third exemplary embodiment of the present invention, showing an example of the shape of a guide.

20 Fig. 4 is a sectional view of a speaker in accordance with the third exemplary embodiment of the present invention, showing another example of the shape of the guide.

Fig. 5 is a sectional view of a speaker in accordance with the third exemplary embodiment of the present invention, showing still 25 another example of the shape of the guide.

Fig. 6 is a sectional view of a speaker in accordance with the third exemplary embodiment of the present invention, showing yet another example of the shape of the guide.

Fig. 7 is a sectional view of a speaker in accordance with the third exemplary embodiment of the present invention, showing still another example of the shape of the guide.

Fig. 8 is a sectional view of a speaker module in accordance with 5 a fourth exemplary embodiment of the present invention.

Fig. 9 is a sectional view of electronic equipment in accordance with a fifth exemplary embodiment of the present invention.

Fig. 10 is a sectional view of a device in accordance with a sixth exemplary embodiment of the present invention.

10 Fig. 11 shows steps 12A through 14C of manufacturing a speaker of the present invention.

Fig. 12A shows step 12A of manufacturing the speaker of the present invention.

15 Fig. 12B shows step 12B of manufacturing the speaker of the present invention.

Fig. 13A shows step 13A of manufacturing the speaker of the present invention.

Fig. 13B shows step 13B of manufacturing the speaker of the present invention.

20 Fig. 13C shows step 13C of manufacturing the speaker of the present invention.

Fig. 14A shows step 14A of manufacturing the speaker of the present invention.

25 Fig. 14B shows step 14B of manufacturing the speaker of the present invention.

Fig. 14C shows step 14C of manufacturing the speaker of the present invention.

Fig. 15 is a sectional view of the speaker of the present

invention.

Fig. 16 is a sectional view of a conventional speaker.

REFERENCE MARKS IN THE DRAWINGS

5	21	Permanent magnet
	24	Magnetic circuit assembly
	25	Magnetic gap
	26	Frame
	27	Diaphragm
10	28	Voice coil
	29	Edge
	35	Speaker
	40	Electronic circuit
	41	Circuit board
15	42	Electronic component
	50	Speaker module
	80	Portable telephone (electronic equipment)
	90	Automobile (device)
	100	Diaphragm assembly
20	110	Positioning jig
	200	Crossover portion

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Hereinafter, a description is provided of exemplary embodiments of the present invention with reference to the accompanying drawings.

FIRST EXEMPLARY EMBODIMENT

Fig. 1 is a sectional view of a speaker in accordance with the first exemplary embodiment of the present invention. Permanent magnet 21 is sandwiched between upper plate 22 and yoke 23 to form magnetic circuit assembly 24. Frame 26 is fitted to yoke 23.

5 Diaphragm 27 and voice coil 28 attached to the outer periphery of diaphragm 27 form diaphragm assembly 100. Edge 29 supports diaphragm assembly 100 with respect to frame 26 so that voice coil 28 is placed in magnetic gap 25 in magnetic circuit assembly 24. Edge 29 is bonded to frame 26 along the outer periphery thereof, and joined

10 to diaphragm 27 in a position more peripherally inward than voice coil 28 along the inner periphery thereof. Therefore, edge 29 partly ~~overlap~~overlaps diaphragm 27.

Now, the portion in which edge 29 overlaps diaphragm 27 is referred to as crossover portion 200. Crossover portion 200 is

15 structured so that a portion in which edge 29 overlaps diaphragm 27 is ensured, other than the bonding portion, i.e. a joint of edge 29 and diaphragm 27. This structure can reduce the outer diameter of the speaker, without reducing the sizes of permanent magnet 21 and edge 29, and thus without deteriorating the performance of the speaker.

20 Diaphragm 27 and edge 29 are structured of a polymer film sheet made of polyethylene naphthalate (PEN), polyether imide (PEI), or polyamide imide (PAI), for example; a metal sheet; a cloth sheet; or a paper sheet. The use of these sheet materials is useful to improve the sound level and productivity of the speaker.

25 Diaphragm 27 and edge 29 can be made of different materials. In other words, a material having a physical property appropriate for a diaphragm is used for diaphragm 27; a material having a physical property appropriate for an edge is used for edge 29. Four examples

are shown below.

(Example 1)

When a material thinner than that of diaphragm 27 is used for edge 29, hard and thicker diaphragm 27 reproduces high tones with high fidelity while expanding the higher limit frequency thereof. Thinner edge 29 allows voice coil 28 and diaphragm 27 to easily vibrate, lower the F0 of the speaker, and thus reproduce low tones with high fidelity.

(Example 2)

When a material softer than that of diaphragm 27 is used for edge 29, harder diaphragm 27 reproduces high tones with high fidelity while expanding the higher limit frequency thereof. Softer edge 29 allows voice coil 28 and diaphragm 27 to easily vibrate, lower the F0 of the speaker, and thus reproduce low tones with high fidelity.

15 (Example 3)

When material having larger internal loss than that of diaphragm 27 is used for edge 29, diaphragm 27 having smaller internal loss reproduces high tones with high fidelity while expanding the higher limit frequency thereof. Edge 29 having larger internal loss reduces unnecessary resonance of the edge and stabilizes the frequency characteristics.

(Example 4)

Disposing a tangential rib in edge 29 improves the vibrating characteristics of edge 29 and further reduces distortion.

25 In order for each of diaphragm 27 and edge 29 to exert its optimum characteristics, it is preferable that the diameter of the joint of diaphragm 27 and edge 29 ~~is--does not exceed~~ 70% of the outer diameter of edge 29. In other words, enlarging edge 29 can

improve the performance of the speaker.

SECOND EXEMPLARY EMBODIMENT

Fig. 2 is a sectional view of a speaker in accordance with the 5 second exemplary embodiment of the present invention. A description is provided only of the difference from the first exemplary embodiment.

Through-hole 27a is provided in a portion of diaphragm 27 covered by edge 29. This structure allows communication of air in 10 and out of a space enclosed by diaphragm 27 and upper plate 22 through through-hole 27a, thus allowing smooth vibration of diaphragm 27. This smooth vibration lowers the F0 of the speaker, improves the capability of reproducing low tones, and decreases distortion, thus improving the frequency characteristics.

15 When more smooth communication of air in and out of the enclosed space is desired, a through-hole can be provided through magnetic circuit 24 or frame 26 to allow the air to flow directly to the outside.

20 THIRD EXEMPLARY EMBODIMENT

Figs. 3 through 7 are sectional views of speakers in accordance with the third exemplary embodiment of the present invention. A description is provided only of the difference from the first exemplary embodiment. As shown in Fig. 3, guide 27b is provided in the joint of 25 diaphragm 27 and edge 29. This structure allows precise positioning of diaphragm 27 and edge 29 when they are being joined to each other.

Fig. 4 shows recess 27c, as another example of the guide. Fig. 5 shows horizontal recess 27d as still another example of the guide.

Fig. 6 shows recess 27e having a U-shaped section, as yet another example of the guide. Fig. 7 shows recess 27f having a V-shaped section, as still another example of the guide.

5 FOURTH EXEMPLARY EMBODIMENT

Fig. 8 is a sectional view of a speaker module in accordance with the fourth exemplary embodiment of the present invention. Speaker module 50 is structured by integrating speaker 35 of the present invention and electronic circuit 40. Electronic circuit 40 is structured 10 of circuit board 41 and electronic component 42. Because electronic circuit 40 has a circuit for amplifying voice signals to be supplied to speaker 35, only connecting speaker module 50 to a source of the voice signals can provide voice output.

Further, electronic circuit 40 may include: circuits necessary for 15 communication, e.g. a detector circuit, modulator circuit, and demodulator circuit; a driver circuit for a display means, e.g. a liquid crystal display; and a power supply circuit and charging circuit.

FIFTH EXEMPLARY EMBODIMENT

20 Fig. 9 is a sectional view of an essential part of a portable telephone (electronic equipment) in accordance with the fifth exemplary embodiment of the present invention. The electronic equipment, e.g. a portable telephone, incorporates speaker 35 of the present invention, electronic circuit 40, and display module 60, e.g. a 25 liquid crystal display, inside of case 70.

SIXTH EXEMPLARY EMBODIMENT

Fig. 10 is a sectional view of an automobile (device) in

accordance with the sixth exemplary embodiment of the present invention. The device, e.g. automobile 90, incorporates speaker 35 of the present invention in a rear tray or front panel thereof to use the speaker as a part of a car navigation or car audio system.

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SEVENTH EXEMPLARY EMBODIMENT

Fig. 11 is a block diagram showing steps 12A through 14C of manufacturing a speaker (see Fig. 15) of the present invention.

Fig. 12A shows manufacturing step 12A of Fig. 11. Fig. 12B shows manufacturing step 12B of Fig. 11. In step 12A, permanent magnet 21 and upper plate 22 are bonded to yoke 23. In step 12B, the bonding is performed with a cap gage (not shown) inserted in magnetic gap 25. Thus, magnetic circuit assembly 24 is formed.

Fig. 13A shows manufacturing step 13A of Fig. 11. Fig. 13B shows manufacturing step 13B of Fig. 11. Fig. 13C shows manufacturing step 13C of Fig. 11. In step 13A, voice coil 28 is attached to diaphragm 27 obtained by pressing a resin sheet material into a shape to form diaphragm assembly 100. In step 13B, frame 26 made of a resin material is prepared. In step 13C, diaphragm assembly 100 and frame 26 are inserted into positioning jig 110 to be positioned precisely. In other words, as shown in Fig. 13C, positioning jig 110 positions the inner diameter of diaphragm assembly 100 and the inner diameter of frame 26 precisely.

Fig. 14A shows manufacturing step 14A of Fig. 11. Fig. 14B shows manufacturing step 14B of Fig. 11. Fig. 14C shows manufacturing step 14C of Fig. 11. In step 14A, the outer periphery of edge 29 is bonded to frame 26, and the inner periphery of edge 29 is joined to diaphragm 27. In step 14B, positioning jig 110 is removed.

In step 14C, in place of removed positioning jig 110, magnetic circuit assembly 24 obtained in step 12B is inserted and attached to frame 26. Thus, a speaker of the present invention shown in Fig. 15 is obtained.

5 INDUSTRIAL APPLICABILITY

A speaker of the present invention finds widespread application in electronic equipment requiring downsizing, such as audio visual equipment, telecommunication equipment, and game machines.

ABSTRACT

An edge (29) for supporting a diaphragm assembly (100) with respect to a frame (26) is bonded to the frame (26) along the outer periphery thereof and joined to a diaphragm (27) in a position more 5 peripherally inward than a voice coil (28) along the inner periphery thereof. The edge (29) partly overlaps diaphragm (27). This structure allows downsizing of the speaker, without reducing the sizes of a permanent magnet (21) and the edge (29).